

SOLAS Brazil

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Notes:

Reporting Period is January 2013 – December 2013

UERJ – Rio de Janeiro State University; FURG – Federal University of Rio Grande; UFPE – Federal University of Pernambuco; UESC – Santa Cruz State University; UFF – Federal Fluminense University.

1. Scientific highlights

1. Sampling of net sea-air CO₂ fluxes in less documented ocean margins

Studies of the carbonate system in the coastal environments has become of great concern to the scientific community. In the framework of the Brazilian High Latitudes Oceanography Group (GOAL; www.goal.furg.br), led by the Federal University of Rio Grande (FURG), Brazil, an integrated multidisciplinary research involving several national institutions was established to focus on physical, chemical, bio-optical, and biological studies of the oceans. In this context, the spatial and temporal variability of air-sea CO₂ fluxes (FCO₂) were investigated around the Antarctica Peninsula (successive summers from 2008 to 2010), the Argentinian Patagonia continental shelf-break (from 2007 to 2009) and in the continental shelf and slope of the South-western subtropical Atlantic (spring 2010 and summer 2011) (Fig.1). In addition to the high variability in the FCO₂ distribution, due to complex interactions between biogeochemical and physical processes in these regions, those studies add observation datasets in less documented areas of the ocean margins, that can significantly contribute to better estimates the oceanic uptake of atmospheric CO₂. A paper, entitled “Net sea-air CO₂ fluxes in the South-western subtropical Atlantic continental shelf during spring 2010 and summer 2011”, from Ito, R.G. et al., is in its final draft version to be submitted to *Continental Shelf Research*.

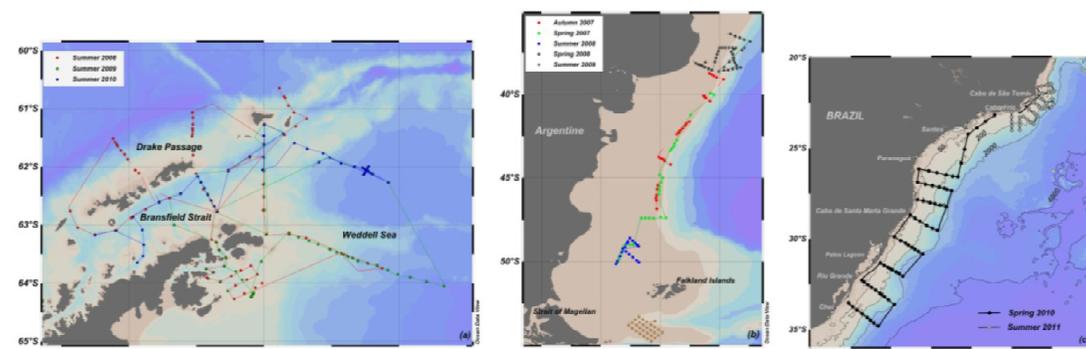


Fig. 1 - Study areas showing pCO₂ sampling (lines) and hydrographic stations (dots), related to oceanographic cruises in the Antarctica Peninsula (a), Argentinian Patagonia (b) and in the South-western subtropical Atlantic (c).

2. International interactions and collaborations (including contributions to international assessments such as the IPCC, links with observation communities, links with policy makers or socio-economics circles, etc.)

→ 2nd *International Workshop on "Global Ocean Acidification Observing Network (GOA-ON)"*. St. Andrews, UK, 24-26 July 2013. The participation of the BrOA leader Dr. Rodrigo Kerr in this workshop gave BrOA an opportunity to start contacts with other international group, especially with South American groups developing research on ocean acidification issues. Also, to met the Director of the NOAA Ocean Acidification Program, Dr. Libby Jewett, was beneficial for the whole group as she was invited to collaborate with the first meeting organized by the group after BrOA implementation.

→ 3rd *Brazilian Workshop on "Climate Change in coastal zone"*. Florianópolis, SC, Brazil, 9-13 December 2013. The workshop considered three main themes: 1) Biogeochemistry of carbon and ocean acidification, 2) Oceans and coastal observational systems, and 3) Network monitoring of coastal benthic habitats. The workshop was convened by Zonas Costeiras - REDE Clima, INCT-Mudanças Climáticas & REBENTOS, and sponsored by CNPq, CAPES, FAPESP, FURG, USP and UFSC. Over 200 scientists are expected to attend the symposium, including five international invited speakers: Dr. Thomas C. Malone (University of Maryland, USA), Dr. Tim Moltmann (IMOS, Australia), Dr. Colin Woodroffe (GeoQUEST / University of Wollongong, Australia), Dr. Libby Jewett (NOAA, USA), and Dr. Steven Crooks.

→ *"Building the Marine Science - French/Brazilian Meeting"*. Búzios, Brazil, 4-8 November 2013. This Colloquium aimed to create new interactions in all fields of Marine Sciences between Brazil and France. Research Groups from both countries have presented their current activities and a future structured, official, cooperation agreement is sought. BrOA co-leader Leticia Cotrim da Cunha has presented the group's main activities in 2013, emphasizing some already on-going Brazilian-French cooperation in the field of ocean acidification, sea-air CO₂ fluxes, and biogeochemistry modelling. BrOA members Bastiaan Knoppers and Luiz Cotovitz Jr (UFF) have presented their work on sea ↔ air CO₂ fluxes at Guanabara Bay, Rio de Janeiro, in cooperation with Gwenael Abril (CNRS, Uni-Bordeaux, France).

→ Leticia Cotrim da Cunha has participated as an expert reviewer to the IPCC Fifth Assessment Report – WG 1 (The Physical Science Basis).

3. Activities/main accomplishments (research projects, cruises, special events, workshops, remote sensing used, model and data intercomparisons etc.)

**Research projects (Approved projects in 2013 and ongoing projects)*

→ The project EstARte-Sul, led by Dr. Rodrigo Kerr, was funded by the Rio Grande do Sul State agency FAPERGS to be conducted between Dec-2013/Dec-2015. The project will be responsible to measure the biogeochemical parameters along the south-south-east Brazilian continental slope. Two cruises are planned to occur along the south-south-east Brazilian continental slope, under the umbrella of the project EstARte-Sul, between 2014-2015. Cruises' dates to be defined later.

→ The project NAUTILUS (New autonomous technologies to investigate and monitor Antarctic Bottom Water in the Weddell Sea and Antarctic Peninsula) was funded by the Brazilian Antarctic Programme via CNPq (Federal Government Agency). Activities are expected to start in austral summer 2014/2015. This project, led by Dr. Maurício Mata (FURG), also counts with the cooperation of researchers from Sao Paulo University (USP) and Rio de Janeiro State University (UERJ), as well as from Alfred-Wegener Institute – AWI (Germany), British Antarctic Survey – BAS (UK), University of Southampton – NOCS (UK), University of East Anglia – UEA (UK), University of Alaska Fairbanks – UAF (USA), The State University of New Jersey – Rutgers (USA), Servicio de Hidrografia Naval – SHN (Argentina), and Universidad de Buenos Aires – UBA (Argentina).

→ The ongoing research programme INCT AMBTROPIC (National Institute on Science & Technology in TROPICAL MARINE ENVIRONMENTS, <http://www.inctambtropic.org/>), funded by federal agency CNPq, and executed by a consortium of 20 institutions involving circa 200 researchers, has 2 research themes directly related to SOLAS, CLIVAR and PIRATA activities:

- **GT3.1 – Ocean-Atmosphere Interaction, Climatic Variability and Predictability in the North-north-east of Brazil and in the Tropical Atlantic:** Processes derived from the ocean-atmosphere interaction are partially responsible for the climate variability at different spatial and temporal scales. For instance, the monsoon system in South America (especially characterized by the rainy season in the basin of the Amazon river during the southern summer and by the presence of the South Atlantic Convergence Zone (SACZ)), and the distribution of rainfalls in the North of Brazil (NB) and North-east of Brazil (NEB) are modulated by intra-seasonal to inter-decennial variability of sea surface temperature in the Pacific and Atlantic. The variability of precipitation, evaporation and inflow of fresh water from rivers is directly associated with the variability of surface salinity, and therefore it is an indicator of the intensity of the hydrological cycle over oceanic regions. *WG PIs: Marcus Silva (UFPE) & Doris Veleda (UFPE).*
- **WG 3.2 – Biogeochemical Cycles, CO₂ Fluxes and Acidification of the Tropical Atlantic Ocean:** Although the tropical Atlantic is known as a source of CO₂ to the atmosphere, very little is known about the spatial and seasonal-interannual variability in the CO₂ flux along the air-sea interface in this oceanic region, while much less is known about its long-term progress in times of increased atmospheric CO₂. However, if the tropical Atlantic operates globally as a source of CO₂ to the atmosphere, specific and important regions have been characterized as CO₂ capturing areas, such as the oceanic areas located near the discharges of large rivers such as the Amazon. This WG main objective is to study the oceanographic processes controlling the variability of biogeochemical properties of the tropical Atlantic Ocean. The intent of this proposal is to increment the capability to predict the responses of the tropical Atlantic to the increasing human activities, particularly those associated with capture and cycling of atmospheric CO₂ and potential ocean acidification. *WG PIs: Moacyr Araújo (UFPE) & Nathalie Levêfre (IRD, France).*

**Cruises*

→ Frédéric K. Bonou (PhD student, Federal University of Pernambuco – UFPE) participated to the German cruise M98 between 01 to 28 July 2013, from Fortaleza (Brazil) to Namibia (Africa) aboard RV Meteor (chief Scientist: Prof. Dr. Peter Brandt, GEOMAR, Germany). During the cruise underway fCO₂, N₂O and DMS measurements were made, together with nutrient analysis. Direct measurements of CO₂ flux using the eddy covariance technique led by Tobias Steinhoff from GEOMAR (Germany) were also performed: Eddy covariance air-sea fluxes were determined by measuring the vertical wind fluctuations simultaneously with the fluctuations in the concentration of the CO₂. The flux is the covariance of the two quantities. Since these measurements are made on a moving platform, the winds were corrected for the platform motion before correlating. Winds were measured using Campbell CSAT 3 sonic anemometers and the ship motion was measured using a Systron Donner MotionPak II. These devices were rigidly mounted directly on the mast, ideally 10 m above the sea surface. The CO₂ flux measurements were made with a LICOR 7500.

→ Luiz Cotovitz Jr. (PhD student, Federal Fluminense University, UFF), Bastiaan A. Knoppers (Professor, UFF), Nilva Brandini (posdoc, UFF), Suzan J. C. Santos (UFF), Ludmila P. Costa (UFF) and Gwenael Abril (CNPq – Université de Bordeaux, France) are currently performing continuous measurements of pCO₂ in subsurface waters of Guanabara Bay (Rio de Janeiro), one of the most eutrophic coastal systems in the world. The campaigns include horizontal profiling of continuous

and georeferenced pCO₂, dissolved oxygen (DO), pH, salinity, temperature and chlorophyll-a (fluorescence). The results indicate that the Bay can be separated in 5 sectors related to pCO₂ spatial distributions: 1) Marine domain: levels of pCO₂ between 350-650 ppm and mesotrophic conditions; 2) "Rio de Janeiro Harbour Domain", with salinities between 27 and 31, hypoxic-anoxic conditions, highest pCO₂ concentrations (800-3000 ppm), and outgassing flux; 3) The central domain, with the more constant values of pCO₂ in the Bay (350-450 ppm); 4) The Guapimirim domain, receiving relatively unpolluted freshwater from rivers, high variations of pCO₂ concentrations (350-1100 ppm); 5) The Governador Island Domain, hypertrophic conditions, where the pCO₂ showed high diurnal variations (50-2200 ppm), turning from CO₂ sink at daytime to CO₂ source at night time. The processes of production/respiration of organic matter and the proximity of the effluent discharge are the most important factors of the pCO₂ dynamics in the bay, overcoming the influences of atmospheric anthropogenic CO₂ (ocean acidification hypothesis).

*Events

During the Seminar "Antarctica, 2048: climate changes and global balances", held in Porto Alegre, RS, Brazil, in November 2013, a special section mediated by Dr. Rodrigo Kerr was dedicated to "Climate change: impacts of a global environment", with a discussion of Ocean Acidification in Antarctic environment given by Dr. Rosane G. Ito. More information about the event at the website <http://www.antartica2048.com.br/>.

4. Human dimensions (outreach, capacity building, public engagement etc.)

- Barbara R. Pinheiro (PhD Student from UFPE, Recife) participated to the Ocean Acidification summer course at Friday Harbor Labs, University of Washington, USA, from 22 July to 23 August 2013. The course served as a rapid indoctrination into essential topics in geochemistry, de-mystifying this essential piece of ocean acidification research throughout lectures on fundamental topics, practical discussions of measuring techniques and equipment and extensive laboratory experience with the critical measurement tools. And most important we gained experience with a range of techniques for conducting experimental manipulations of environmental conditions (analysing dissolved inorganic carbon, total alkalinity and Spec-pH).
- BrOA student BSc. Iole B. M. Orselli (FURG, Rio Grande) participated to the summer school "Biogeochemical cycles in highly productive marine ecosystems" was held in Buenos Aires, between 2-14 December 2013. The course proposed reviewed the basis of the biogeochemical process in the ocean and showed examples of highly productive regions. Dr. Michelle Ivette Graco (IMARPE, Peru) taught the main classes, with invited lecturers presenting the knowledge of the physical and biophysical process. This event was a valuable opportunity to the student, as her master studies focus on anthropogenic carbon quantification in the Patagonian shelf-break.
- Frédéric K. Bonou (PhD Student from UFPE, Recife) participated to Germany cruise M98 occurred between 30 June to 29 July, from Fortaleza (Brazil) to Namibia (Africa) aboard of Meteor Ship Fig2. Aboard of this ship each scientific participant gave a presentation focusing on the main results of their own research project.

5. Top 10 publications in 2013 (Reports, ACCEPTED articles, models, datasets, products, website etc.)

BrOA website - www.broa.furg.br

da Cunha L C & Kerr R, 2013, *Brazilian Research on Ocean Acidification (BROA)*, Building the Marine Sciences, a Brazil-France Meeting, Búzios, Brazil, Available on-line at <http://marinebrazil.sciencesconf.org/25807/document>

Kerr R & da Cunha L C, 2012, *1st Brazilian Ocean Acidification Research report*, 22p. Released on-line in September 2013 at <http://joomla.furg.br/broa/images/doc/BROA.pdf>

Kerr R, da Cunha L C, de Souza M F L, Wainer I, Ito R G, Calil P H R & Garcia C A E, 2013, *Activities of the Brazilian Ocean Acidification Research (BROA) group*, 2nd International Workshop: Global Ocean Acidification Observing Network, St. Andrews, UK, poster nº 16, pp 14-15. Available on-line at <http://www.nerc.ac.uk/research/programmes/oceanacidification/events/documents/goa-on-booklet.pdf>

da Cunha L C, Buitenhuis E T, 2013, Riverine influence on the tropical Atlantic Ocean biogeochemistry. *Biogeosciences*, 10,6357–6373. doi: 10.5194/bg-10-6357-2013.

Abril G, Martinez J-M, Artigas LF, Moreira-Turcq P, Benedetti MF, Vidal L, Meziane T, Kim J-H, Bernardes MC, Savoye N, Deborde J, Souza EL, Albéric P, Landim de Souza MF*, Roland F. Amazon River carbon dioxide outgassing fuelled by wetlands. *Nature*, December 2013, advance on, doi: 10.1038/nature12797.

* Marcelo F. Landim de Souza (Universidade Estadual de Santa Cruz – UESC, Ilhéus, Bahia)

6. Goals, priorities and plans for future activities/events

The short term goal established by BrOA group (i.e. to identify and to integrate the Brazilian scientific community that studies aspects related with ocean acidification issues) in our 1st Report was fully completed during 2013, being finalized with the release of the 2nd report after the Florianopolis meeting in early 2014.

Our medium term goals include: 1) implementing the necessary scientific equipment and analyses certification for ocean acidification research; 2) participation of Brazilian laboratories to international inter-calibration exercises, and 3) strengthen the cooperation with experimented international groups.

BrOA is planning for the next year a South American meeting on "Ocean Acidification Issues" to be held in the second semester, probably concomitant to the PIRATA Meeting at Recife. The meeting aims to better connect the activities and collaborations between South American researchers on this topic and to establish possible collaborations among the biogeochemistry branch of PIRATA.

Coming in 2014:

- The coastal buoy network SIMCOSTA, coordinated by FURG, will start its activities. The continuous measurements include meteorological, sea-level, oceanographic and biogeochemistry measurements in 4 buoys located over the southern Brazilian coastal zone. Real-time data will be available at <http://www.simcosta.furg.br/portal/>.
- UERJ's proposal entitled "Rio de Janeiro Coastal and Ocean Monitoring System (SiMOC)" was funded by FINEP (federal agency). It includes the deployment of a *meteorological-oceanographic-biogeochemistry buoy off Rio de Janeiro shelf, an eddy-covariation tower for CO2 measurements in a mangrove area*, and an analytical facility for measuring PAH contamination in biological samples.

7. Other comments

The Brazilian Research Group on Ocean Acidification (BrOA) was created in December 2012 during the Workshop "Studying Ocean Acidification and its effects on marine ecosystems", organized by the Brazilian IGBP Office, São Paulo University (USP), Federal Council for Research and Development (CNPq), and the National Institute for Space Research (INPE).

We also aim at improving at national level our capacity building and scientific equipment, as well as contributing to current international programmes like SOLAS, IMBER, CLIVAR, and LOICZ.

The PIs of the above mentioned INCT AMBTROPIC programme (some being also BrOA members) are planning to submit SOLAS IPO a request for endorsement in 2014.